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THE POSSIBILITY OF AN IMPROVED WATER FROM DEEP WELLS IN NORTHERN ILLINOIS[1]

By C. B. Williams

The geology of Northern Illinois is fairly well known from the numerous wells drilled throughout this district, but the quality of the waters supplied by various strata of water-bearing rock has not been so well investigated. Most deep wells throughout this territory supply a water which is a composite, being a mixture of all good and bad water encountered in the sinking of the well.

The distinction between good and bad is not made from a sanitary stand point, as most of the deep well supplies are of unquestioned hygienic purity, but rather from their suitability for commercial and domestic purposes. Nearly all of these waters are unsatisfactory for boiler and laundry uses, as they are extremely hard and often contain objectionable iron salts.

In making a selection among the various strata of water-bearing rock, it is apparent that the lime rock may be eliminated as a medium for producing a soft water, hence we necessarily turn to the two sand rock strata as being the only possible source for a satisfactory water. A study of the general formation of these strata, the nature and conditions of their source of water supply gives a clue to the probable kind of water we may expect to obtain from each.

The Potsdam sandstone lies just above the Archean bed and varies in thickness from a few hundred to over 1500 feet, and is interspersed with layers of limestone and shale. Lying over the Potsdam sandstone is a rather thin, generally impervious blanket of limestone known as the Lower Magnesium. Over this limestone is the St. Peter sandstone usually several hundred feet thick, which in turn is overlaid with the Trenton limestone, Hudson shale and Niagara limestone successively, the latter two having been eroded in the central part of the field.

These successive layers of rock rise gradually toward the north and west and outcrop in Wisconsin, Minnesota and Northern Michigan. The Archean rock outcrops the furthest north, in a broad irregular area, extends as far south as Chippewa Falls and Wausau, Wisconsin. South of the Archean rock is the Potsdam outcrop in a V-shaped belt covering about 14,000 square miles, the apex of the V extending as far south as Madison, Wisconsin. Next south is an outcrop belt of Lower Magnesium limestone and southerly of this is the outcrop of the St. Peter sandstone in Southern Wisconsin and Northern Illinois, having an area of about 2000 square miles.

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[1] Read at first annual meeting Illinois Section, American Water Works Association, March 10, 1915.

These outcrops mostly covered with a pervious blanket of soil and gravel are the intakes so to speak of these sandstone underground channels. The general surface drainage of the main part of this territory of Wisconsin is south and southwesterly, hence the numerous streams crossing the Potsdam outcrop rise in and flow over Archean and sand rock and are less liable to become charged with lime and magnesium salts; on the contrary the streams feeding the St. Peter sandstone have previously traversed the limestone district of the Lower Magnesium outcrop, thereby becoming impregnated with the hardening salts of lime and magnesium.

These observations would lead us to believe that the Potsdam sandstone would furnish a softer water in general than that from any other strata, and as a verification of this, the results obtained from some wells sunk in Cook County are of interest.

The Chicago, Milwaukee & St. Paul Railway Co. and the Chicago and Northwestern Railway Co. have both successfully improved their water supply for boiler purposes, by casing off portions of the waters in their wells. Also the village of Western Springs has sunk a deep well and cased out certain waters, thereby greatly improving its supply, but not to the same extent as in the case of the railroads.

The Milwaukee wells are located on the Chicago and Council Bluffs division, about two miles west of Mannheim. There are at least five, the records of which are available, and all of which show similar characteristics.

The log of well No. 1 following, is typical:

Ground level 679 feet above sea level

		feet		*feet*
Niagara limestone	from	62	to	260
Hudson shale	from	260	to	455
Trenton limestone	from	455	to	785
St. Peter sandstone	from	785	to	1060
Lower magnesium limestone	from	1060	to	1262

		feet		fect
1st Potsdam sandstone	from	1262	to	1450
Limestone, shale, etc	from	1450	to	1705
2d Potsdam sandstone	from	1705	to	1804
Limestone	from	1804	to	1820
3d Potsdam sandstone	from	1820	to	2290

Caves were encountered at 570 feet to 590 feet, 1060 feet to 1070 feet and 1085 feet to 1095 feet. These caves were taken care of by casing. The lower and third Potsdam sandstone is composed of beds of different thickness, color and hardness.

The well is cased from the surface to a depth of 1262 feet where the casing is sealed to the rock walls by concrete.

The following are analyses of the water at various depths below the casing, given in grains per gallon:

Depths (feet)	1450	2030	2128	2290
Oxides	Undetermined	Undetermined	Undetermined	Undetermined
Calcium carbonate	2.94	5.34	6.64	10.22
Calcium sulphate	4.61			3.95
Magnesium carbonate	0.27	2.10	2.87	3.88
Incrustating solids	7.82	7.44	9.51	18.05
Alkali carbonates		7.81	8.92	
Alkali sulphate	7.47	10.50	4.82	3.17
Alkali chlorides	3.38	4.68	12.44	50.96
Non-incrustating solids	10.85	22.99	26.18	54.13
Total	18.67	30.43	35.69	72.18

This well which is the deepest, shows a large increase in incrustating solids toward the bottom, and also a large increase in salt contents. This was avoided in the other wells of the series by lessening the depth by about fifty feet. The yield of these wells varied from 130 to 170 gallons per minute.

The Northwestern Railway drilled a chain of wells at Proviso, Cook County, Illinois, on the Galena Division, about four miles south of the Milwaukee wells. These wells were spaced from three to six hundred feet apart, and all showed similar characteristics as to depth of strata and as to quality of water. The log of well No. 3 is typical.

Surface of ground, elevation above sea level 645 feet

		feet		feet
Niagara limestone	from	73	to	245
Hudson shale	from	245	to	478
Trenton limestone	from	478	to	810
St. Peter sandstone	from	810	to	1010

		feet		feet
Lower magnesium limestone	from	1010	to	1220
Sandy shale	from	1220	to	1320
1st Potsdam sandstone	from	1320	to	1520
Limestone	from	1520	to	1747
2d Potsdam	from	1747	to	1830

Caves were encountered here only between the St. Peter sandstone and the Lower Magnesium limestone. This well was cased to a depth of 1690 feet and was only drilled to a depth of 1830 feet. The following is an analysis from the water at that depth given in grains per gallon:

Calcium carbonate	4.20	
Magnesium carbonate	1.46	
Iron and aluminum	0.06	
Silica	0.46	
Incrustating solids		6.18
Alkali chlorides	4.10	
Alkali sulphates	4.04	
Alkali carbonates	10.08	
Non-incrustating solids		18.22
Total		24.40

This well, as the others in the series, was cased to a greater depth than the Milwaukee series on account of the poor quality of water found in the first Potsdam sandstone. The yield varied from about 60 to 150 gallons per minute, and the pumping of two alternate wells 600 feet apart to a depth of 242 feet lowered the water in the third intermediate well 97 feet.

The village of Western Springs, Illinois, has just completed a well in which the results obtained conform generally to those found in the Milwaukee and Northwestern wells.

This well is ten miles due south of the Milwaukee well in the township of Lyons about one-half mile from the west line of Cook County.

The following is a log of this well:

Surface of the ground, above sea level, 648 feet.

		feet		feet
Niagara limestone	from	73	to	360
Hudson shale	from	360	to	474
Trenton limestone	from	474	to	790
St. Peter sandstone	from	790	to	1244
Lower magnesium limestone	from	1244	to	1337
1st Potsdam sandstone	from	1337	to	1490
Limestone	from	1490	to	1765
2d Potsdam sandstone	from	1765	to	2046

This well was cased down to a depth of 1765 feet as the water from the first Potsdam and underlying limestone was very unsatisfactory, as may be seen from the following analyses, given in grains per gallon:

	Above 1st Potsdam 1337 feet	*1st Potsdam and limestone 1337 feet–1765 feet*	*Below Casing 1765 feet–2046 feet*
Calcium carbonate	21.23	21.46	13.42
Calcium sulphate	3.74	1.11	
Magnesium carbonate			4.80
Magnesium sulphate	15.11	15.12	2.10
Iron carbonate		0.27	0.12
Undetermined	0.55	2.21	0.99
Incrustating solids	40.63	40.17	21.43
Sodium sulphate	2.69	5.45	8.85
Sodium chloride	0.29	0.77	24.06
Sodium nitrate		0.04	
Non-incrustating solids	2.98	6.26	32.91
Total	43.61	46.43	54.34

This well is rather unique in that in placing the casings the one through the drift is made big enough to allow small suction pipes to be dropped between it and the inner casing thus making the water from either the upper or lower strata available. The available supply from the lower strata for a draw down of 150 feet was about 110 gallons per minute.

A study of these three wells bears out to a large degree the assumption that the Potsdam sandstone will give a more satisfactory water than the St. Peter sandstone. It also is evident that all parts of the same stratum cannot be relied upon to give exactly the same quality; this is shown by a comparison of the water from the first Potsdam of the Milwaukee well which shows 7.82 grains per gallon of incrustating solids, while the same stratum in the Northwestern was reported as bad and the Western Springs well showed 40.17 grains per gallon.

It further appears that increasing the depth beyond a certain point will probably increase the hardness without any great return in quantity of water, and that the capacity is limited to approximately 170 gallons per minute, according to the tests on these wells. In the territory around Chicago at least, a limit to the depth is fixed by the increased amount of salt in the lower levels.

More data are needed to establish the conclusions as drawn from these limited cases, and should cover the territory more completely. If, with the increased data, it is found that the above conclusions are generally borne out, it opens up an improved supply for small towns and industrial establishments that may be well worth the extra cost to obtain.